HOP title: Fine Structure and Dynamics of Solar Filaments/Prominences

Plan term: 2015/08/01-2015/08/08

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Abstract: The solar corona contains sheared or twisted magnetic fields overlying polarity inversion lines on the photosphere. The sheared/twisted fields can be observed as filament channels on the disk and as coronal cavities in limb observations; solar prominences are located within these regions. These structures warrant investigation because of their role in prominence eruptions, coronal mass ejections (CMEs), and solar flares. Understanding the topology and evolution of the prominence/cavity magnetic field structure prior to the eruption is key to understanding the onset of solar eruptions. To understand how filaments are supported, we will study the fine structure and dynamics of the observed filament as well as its relation with the corresponding photospheric magnetic fields, and the corresponding structure of the coronal magnetic fields will be reconstructed using photospheric magnetic field observations.

Tornado-like prominences were first described by Pettit (1932) but have not been paid much attention thereafter. Recently, several groups (e.g., Su et al. 2012; Wedemeyer-Boehm et al. 2012) observed "magnetic tornadoes" with the AIA instrument onboard SDO, and pointed at possible connections among vortex motion on the surface, filament barbs, and solar tornadoes. However, whether these magnetic structures are indeed rotating, is a key question to be answered. Through cooperative observations between BBSO/NST, Hinode, and IRIS, and SDO we aim to address the following questions: what is the nature of the plasma dynamics in prominence barbs or tornado-like prominence? Do these motions play an important role in the formation and evolution of prominences? What is the relation between prominence barbs and tornado-like prominences? What is the magnetic structure supporting this type of prominence/filament?

Therefore, our primary target is a quiescent filament/prominence with barbs and/or tornado-like features. In the ideal case, we propose to track the filament from disk to west limb.
In case no suitable quiescent filament is available, our target will be changed to an active region with filaments.

In case of quiescent filament/prominence:

Request to SOT: following HOP 269
<Case 1 (prominences at the limb)>: Following HOP 73:

Very high cadence filtergrams and dopplergrams.
FG: Prog. 0x0387
NFI: H-alpha ± 208mA DG, 1408x1408, 2x2 sum, 500 msec exposure.
BFI: Ca II H-line, 2K x 2K, 2x2 sum, 1200 msec exposure.
ROI shift for off-limb.
Cadence = 10-20 seconds.

<Case 2 (filaments on the disk)>: Following HOP 139:

Common for all: FOV=100"x82", sum=2x2
SP - Fast map (cycle 2), cadence=repeat
Ca - cadence=4 minutes, Q=65
G-band - cadence=1 minute, Q=65
(A 1-min cadence is necessary for the calculation of the surface flows.)

Request to XRT: following HOP 264
Thin-Be, Ti-poly, Al-poly filters with longest possible fixed exposures. FOV should include the coronal cavity when at the limb. Large FOV (768”x768”) with 2x2 binning.

Request to EIS: following HOP 237

The high EIS spectral resolution allows to measure Doppler velocities of plasma with very high precision. We would like to take advantage of the EIS spectrometer and study the dynamics of solar tornadoes in the following spectral lines: Fe X 184.54 A, Fe VIII 185.21 A, Fe XI 188.23 A, Ca XVII 192.82 A, Fe XII 195.12A, Fe IX 197.86 A, Fe XIII 202.04 A, He II 256.32 A, Si VII 275.35 A. For this purpose we designed the EIS program consisting of scanning and sit-and-stare observing mode. In the scanning mode, we plan to take the 2D raster (FoV = 100”×256”) of the area above the WEST solar limb with the potential solar tornado (or, alternatively, on the solar disk with filament target). Then, using the sit-and-stare mode, we plan to take sequences of exposures with the slit crossing the tornado to obtain information on the temporal evolution of its dynamical properties.
The technical parameters of the two observing modes are:

Sit-and-stare observing mode: slit: 2"x256"
compression: DCPM
exposure time/delay time: 50.0s/0ms
number of exposures: 70
width of spectral windows: 32 (except for Fe X line: 24)
number of lines: 9
number of study repetitions: 6-8

Scanning observing mode: slit: 2"x256"
step size: 2"
number of steps: 49 (total number of exposures: 50)
final FoV: 100"x256"
compression: DCPM
exposure time/delay time: 50.0s/0ms
width of spectral windows 32 (except for Fe X line: 24)
number of lines: 9
number of study repetitions: 2 (before and after sit-and stare mode)

<u>In case of active region filaments</u>, we can run observations similar to HOP 260.

Other participating instruments:

BBSO/NST, IRIS, SDO

Two observing modes for IRIS：

OBS 3620261403: Large sit-and-stare

OBS 3620261465: Dense synoptic raster

The scanning mode (OBSID 3620261465) should be performed twice before and twice after the sit n stare mode (OBSID 3620261403)

Remarks:

— Target of interest:

Primary: quiescent filament with barbs or tornado-like feature

Secondary: active regions with filament.

— Our observation proposal for BBSO during 2015 August 1-8 has been accepted.

— The daily best-seeing observing time at BBSO is from 17:00 UT to 21:00 UT.